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NESTING BIOLOGY OF THE BAIRD'S SPARROW IN SOUTHWESTERN MANITOBA

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ABSTRACT.—Very few studies have documented aspects of Baird's Sparrow (*Ammodramus bairdii*) nesting biology, apparently because of difficulty in locating their nests. Subsequently much of the information regarding the breeding biology of the Baird's Sparrow is based on small samples of nests and anecdotal information. We studied the nesting biology of the Baird's Sparrow in southwestern Manitoba, during 1991–1992. Baird's Sparrows arrived in the first two weeks of May and initiated clutches as early as 25 May. Clutch initiation peaked between 29 May and 4 June with a second smaller peak occurring in mid- to late July. Seventy-six nests were located with a mean clutch size of 4.6 eggs. The incubation period extended 11–12 days and young fledged between 8 and 11 days of age. Mayfield nest success was 37% with predation being the primary cause of nest loss. Brown-headed Cowbirds (*Molothrus ater*) parasitized 36% of the nests with 67% of these nests containing more than one cowbird egg ($\bar{x}$ = 2.0 ± 0.2 S.E., range = 1–4). Hatching success of non-parasitized nests was significantly higher than that of parasitized nests. In addition, significantly fewer young fledged from successful parasitized nests than from successful non-parasitized nests resulting in an average cost of 1.1 Baird's Sparrow fledglings per parasitized nest. Egg removal by cowbirds was likely the primary cause of lowered productivity in parasitized nests. Baird's Sparrows appear to be a good quality host for cowbirds in southwestern Manitoba as 21% of cowbird eggs laid fledged young with 0.5 cowbirds fledging per parasitized nest. *Received 15 Aug. 1997, accepted 13 Jan. 1998.*

The Baird's Sparrow (*Ammodramus bairdii*) is endemic to the grasslands of the northern Great Plains (Knopf 1994), breeding from northern South Dakota north to southern Alberta, Saskatchewan and southwestern Manitoba (Rising 1996). This species was once considered one of the most common birds on the Manitoba prairies (Thompson 1891), but with a decline of more than 95% of the native mixed-grass prairie in Manitoba (R. E. Jones, pers. comm.), its range is now restricted to fragments of habitat in extreme southwestern Manitoba (Rising 1996). In 1989, the Baird's Sparrow was listed as "threatened" by the Committee On the Status of Endangered Wildlife in Canada (COSEWIC; Goossen et al. 1993), but was subsequently delisted in 1996 (COSEWIC 1996). The Baird's Sparrow is currently listed as an endangered species in Manitoba.

Early studies suggested that the Baird's Sparrow was a native prairie specialist (Cartwright et al. 1937, Owens and Myres 1973), although more recent studies indicate that the species is more flexible in its habitat choice than previously thought. Indeed, the species has been recorded in other habitat types such as seeded pasture, hayland, and cropland (reviewed by Davis et al. 1996). Several studies have focused on habitat requirements of Baird's Sparrows (Dale 1983, Sousa and McDonal 1983, Mahon 1995, Sutter et al. 1995, Davis and Duncan in press) and the effects of different land management practices such as fire, grazing, and haying on the species (Owens and Myres 1973, Kantrud and Kologiski 1982, Dale 1984, Renken and Dinsmore 1987, Pylpec 1991, Winter 1994, Madden 1996). Only one study has documented aspects of the species' nesting biology, apparently because of difficulty in locating their nests (Cartwright et al. 1937, Lane 1968). Subsequently much of the information regarding the breeding biology of the Baird's Sparrow is based on small samples of nests (Cartwright et al. 1937) and anecdotal information.

The objectives of this study were to: (1) examine nesting biology parameters such as egg, nest and clutch size, phenology of clutch initiation, nest construction, timing of egg laying, and length of incubation and nestling periods; (2) quantify nesting success; (3) examine factors influencing nest predation and its effect on nesting success; and (4) determine the frequency and effects of brood parasitism by Brown-headed Cowbirds (*Molothrus ater*) on Baird's Sparrow productivity.

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STUDY AREA AND METHODS

Field work was conducted from 6 May to 17 August 1991 and 1 May to 25 August 1992 on four typical grassland sites in southwestern Manitoba. Site 1 (49° 04′ N, 101° 14′ W) was a square, 64-ha patch of idle hayland comprised predominantly of smooth brome grass (*Bromus inermis*), along with *Stipa spartea, Poa* spp., *Koeleria gracilis,* and *Artemisia frigida.* Site 2 (49° 24′ N, 101° 02′ W) was a square, 64-ha patch of grazed, gently rolling pasture with numerous depressions. Low areas were characterized by *Calamagrostis inexpansa* and sedges (*Carex* spp.), whereas *Agropyron repens, S. spartea* and *Bouteloua gracilis* were predominant on elevated areas. Western snowberry (*Symphoricarpos occidentalis*) and wolf willow (*Eleagnus commutata*) occurred in patches throughout. Site 3 (49° 30′ N, 100° 56′ W) was an irregular-shaped 22-ha strip of native grassland characterized by *S. spartea, Muhlenbergia richardsonis,* and *B. gracilis* and bordered by stands of wolf willow, western snowberry, and *Salix* spp. Although this site was periodically grazed in the past, no cattle were present on the site in 1991 and 1992 (see Davis 1994, Davis and Sealy, in press, for more detailed descriptions of sites 1–3). Site 4 (49° 04′ N, 101° 17′ W) was an irregularly-shaped 20-ha strip of native grassland, comprised of *S. spartea, M. richardsonis,* and *Deschampsia caespitosa.* The site was last hayed in 1990 and was included in the study only in 1991 because of the landowner's intent to hay in 1992.

Each site was marked in a 50-m grid with labelled surveyor flags positioned as close to the top of the vegetation as possible. Baird's Sparrows and Brown-headed Cowbirds were not observed perching on the flags during the course of this study.

Female Baird's Sparrows were flushed from their nests by two persons dragging a weighted 30-m nylon rope with aluminum and tin cans attached every 0.5 m. Each plot was entirely and systematically dragged throughout the field season. To reduce the chances of human-induced nest failure, nest-searches were not conducted during cold, wet weather. Nest-searching commenced each year in the second week of May and finished in the first week of August. Nests were marked with surveyor flags 5 m away and were inspected every 2–4 days until the young fledged or the nesting attempt ended. Because research activities may influence predation rates of ground-nesting birds (Major 1990, but see O'Grady et al. 1996) we took several precautions when checking nests. Before approaching the nest site, we checked the area for potential nest predators and cowbirds. To avoid creating a well-defined path, we approached nests from different directions and attempted to stay about 1 m away when inspecting their contents. Nests were considered successful if at least one nestling (host or cowbird) survived to fledging age. Cues used to determine whether empty nests were successful included a combination of the condition of the nest (i.e., compacted, but not disrupted) and the presence of an adult carrying food or uttering alarm calls nearby. Nest success was evaluated by calculating daily survival rates derived from the incubation and nestling stages (Mayfield 1975). In addition, the proportions of successful and unsuccessful nests are presented for comparison with previous studies which did not use the Mayfield method of calculating nest success.

Clutch initiation dates were calculated for nests found during egg laying by back-dating at a rate of 1 egg laid per day (see below). For other nests, clutch initiation dates were estimated by subtracting the length of the incubation period and the size of the completed clutch from the day hatching began. Clutches were considered complete when the number of eggs was the same for two successive days. The clutch size of Baird's Sparrows was determined from non-parasitized nests and parasitized nests in which the final number of host eggs laid was known. In comparisons of clutch size in parasitized and non-parasitized nests, the clutch size of parasitized nests was defined as the number of host eggs remaining in the nest after host and cowbird laying was complete. Wilcoxon rank sum was used to compare mean clutch size, eggs hatched, and young fledged in parasitized and non-parasitized nests. Nests parasitized during the nestling period or after the nest was terminated were treated as non-parasitized for the above comparisons because cowbirds could not have affected host clutch sizes.

Inside diameter and depth of nests with eggs, and length and width of eggs were measured with calipers to the nearest 0.1 mm. Nest concealment was determined in 1992 only, by using a circular, 6.3-cm-diameter piece of white plastic divided into 8 equal black-and-white sections. The disc was placed horizontally into each nest after nest measurements were taken and the number of visible sections was recorded from 1 m away at five points (each cardinal direction and overhead). Completely exposed nests, therefore, had a value of 40, whereas completely concealed nests were 0. Nest concealment was assessed on sunny days, 5–6 h after sunrise and were only assessed on nests containing eggs or newly hatched young.

A measuring wheel was used to measure the distance of each nest to the nearest perch site after the nesting attempt had ended. Perch sites were defined as any object (e.g., shrub, fence, rock pile, etc.) that was at least 1 m in height (Gochfeld 1979) and could support a cowbird. Distances between nest sites and nearest perches were log-transformed to meet the assumption of normality. Data were lumped if no significant differences were detected between years ($\alpha = 0.05$). Means are presented with standard errors. All analyses were performed using SAS (ver. 6) statistical software.

We also present nesting biology data on Baird's Sparrows from records in the Canadian Prairie Nest Record Scheme (PNRS) for comparative purposes. The Canadian PNRS is a collection of nest records from species nesting in Manitoba, Saskatchewan, and Alberta.

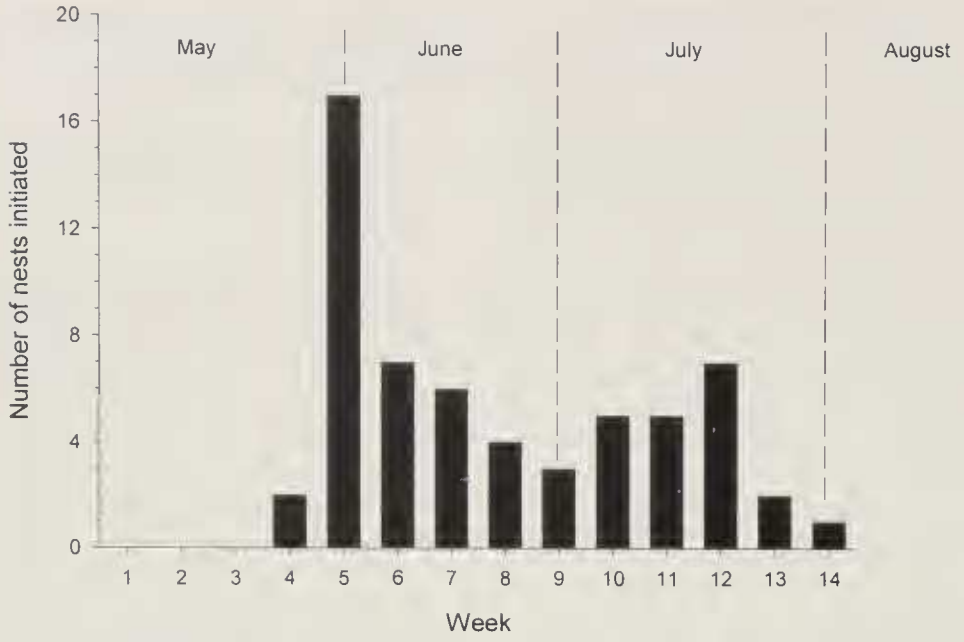

FIG. 1. Frequency distribution of Baird's Sparrow clutch initiation dates in southwestern Manitoba (n = 59 nests). Week 1 = 1–7 May, Week 2 = 8–14 May, Week 3 = 15–21 May, Week 4 = 22–28 May, Week 5 = 29 May–4 June, Week 6 = 5–11 June, Week 7 = 12–18 June, Week 8 = 19–25 June, Week 9 = 26 June–2 July, Week 10 = 3–9 July, Week 11 = 10–16 July, Week 12 = 17–23 July, Week 13 = 24–30 July, Week 14 = 31 July–6 August.

RESULTS AND DISCUSSION

Nesting biology.—The first Baird's Sparrow was recorded on the study area on 10 May 1991 and 4 May 1992, consistent with arrival times recorded in other areas. Belcher (1980), for example, stated that the species usually arrives in south-central Saskatchewan in the second week of May but may be as early as 4 May. In comparison, Baird's Sparrows typically arrive in Alberta in the third week of May (Semenchuk 1992).

Seventy-six nests were located over the two years of the study. Clutch initiation peaked 29 May–4 June with an apparent second, smaller peak in mid- to late July (Fig. 1). The median clutch initiation date was 16 June with the earliest and latest clutches initiated 25 May and 31 July, respectively. Although data from the PNRS (n = 33 nests) revealed that the length of the laying season was the same as in this study, the median clutch initiation date (10 July) was much later. These records, however, were not systematic nest searches conducted throughout the nesting season as in this study, and might reflect a bias towards individuals locating nests later in the season (see below). The nesting season in North Dakota (Stewart 1975) appears similar to what we found with egg dates ranging from 5 June to 21 July for 23 nests examined. In contrast, Cartwright et al. (1937) reported that laying did not begin until mid-June in Manitoba, and Lane (1968) believed that Baird's Sparrows delayed their nesting until late June. In these studies it is unclear as to when the authors initiated nest searches or on how many nests they based their conclusions.

Baird's Sparrows lay one egg per day in the early morning between 05:13 and 07:42 Central Standard Time (CST; Table 1). These laying times are consistent with those found for other grassland songbirds. On 27 and 28 May, 1992, we recorded a Western Meadowlark (*Sturnella neglecta*) laying its fourth egg between 06:19 and 07:10 CST, and its fifth egg between 07:20 and 08:09 CST. Chestnut-collared Longspurs (*Calcarius ornatus*) have been recorded laying their eggs between 06:00 and 07:30 CST (Hill and Gould 1997).

The mean size of 251 Baird's Sparrow eggs

TABLE 1. Timing of egg laying in two Baird's Sparrow nests in southwestern Manitoba.

Nest no.	Egg no.	Laying interval (CST)
37	2	05:13–06:12
37	3	05:18–06:33
37	4	06:41–07:42
140	3	05:35–07:30

TABLE 2. Distribution of Baird's Sparrow clutch sizes (n = 61) in relation to the median clutch initiation date, 16 June.

Clutch size	3	4	5	6
Occurrence (%)	1.6	36.1	60.7	1.6
Before median date (%)	0	50	73	100
After median date (%)	100	50	27	0

was 19.3 ± 0.1 mm long by 14.7 ± 0.0 mm wide with a range of 17.0–21.3 mm long and 13.3–15.6 mm wide. These measurements fall within the range of those given for 18 and 50 eggs by Cartwright et al. (1937) and Lane (1968), respectively.

Mean clutch size was 4.6 ± 0.1 eggs (n = 61) in this study and 4.5 ± 0.1 eggs (n = 24) from the PNRS, similar to that found in North Dakota (n = 15 nests, $\bar{x}$ = 4.7 eggs; Stewart 1975). Clutch sizes in southwestern Manitoba ranged from 3 to 6 eggs with 5-egg clutches being the most common (Table 2). This supports Cartwright's and coworkers' (1937) claim that 5 eggs is the typical clutch size for Baird's Sparrow, although 4-egg clutches occur frequently. Most 5-egg clutches (73%) were initiated before the median clutch initiation date (Table 2) resulting in significantly larger clutches (4.8 ± 0.1) being initiated prior to the median initiation date compared to later dates (4.4 ± 0.1; Wilcoxon rank sum: U = 2.16, P = 0.031). Smaller clutches later in the season may have resulted from reduced metabolic resources as a result of re-nesting and double brooding (Wray et al. 1982), although factors such as age and cost of reproduction may also be involved (reviewed by Rohwer 1992).

Cartwright and coworkers (1937) stated that Baird's Sparrow nests are always placed on the ground amongst grasses and are either: (1) in a tuft of grass supported by a shrub, (2) in a depression beneath an overhanging tuft of grass, or (3) in a deep depression with no overhead concealment. The latter two types more accurately describe nests in this study as 61% of the nests were in depressions situated at the base or within clumps of dead and live narrow-leaf grasses (< 5 mm wide). Twenty-three percent and 16% of the nests were associated with *B. inermis* and *A. frigida*, respectively. *Artemisia frigida* stems were incorporated into the outer lining of those nests built next to it. Nests not associated with *A. frigida* had an outer lining constructed of grass stems and leaves, and an inner lining of fine narrow-leaf grasses and rootlets, similar to that described by Lane (1968). Occasionally bailing twine, cow hair, and red setae from moss were incorporated into the inner lining. None of the nests was directly associated with shrubs in this study despite their occurrence on the sites. However, Baird's Sparrow nests have been found at the base of young western snowberry shrubs (< 40 cm) in native pastures of southern Saskatchewan (Davis, unpubl. data).

Inside dimensions of nests averaged 6.2 ± 0.1 cm in diameter and 4.6 ± 0.1 cm in depth (n = 64 nests), consistent with the inside dimensions reported by Cartwright and coworkers (1937; 6.4 cm diameter and 3.8 cm deep). No significant differences were found for nest diameter and nest depth before and after the median clutch initiation date (Student's t-test: t = 0.741 and t = 0.631, respectively, $P > 0.05$ for both). Thus Baird's Sparrows did not appear to alter nest size in response to warmer temperatures later in the summer, as reported for Western Meadowlarks (Dickinson et al. 1987)

The incubation period of three clutches for which laying and hatching dates were known, ranged from 11–12 days from the last egg laid to the last egg hatched. Lane (1968) found that two Baird's Sparrow nests were also incubated for 11–12 days. Baird's Sparrow young fledged between 8 and 11 days after hatching in 23 nests in which the fledging dates could be determined (see also Cartwright et al. 1937). Allowing five days for laying, 11–12 days for incubation and 8–11 days to fledging, one nesting attempt would take 24–28 days to complete (excluding nest-building time). Because the laying season for Baird's Sparrow is approximately 70 days in Manitoba, sufficient time is available to raise more than one brood. Indeed, we recorded one instance of a Baird's Sparrow producing a second brood. A banded female fledged young at one nest between 13 and 15 July and was recaptured 50 m north at a second nest that she initiated on 20 or 21 July. Thus 5–8 days elapsed from the fledging of the first brood to the initiation of the second nest. Indirect evidence of possible double-

TABLE 3. Baird's Sparrow nest success and productivity in southwestern Manitoba (MB) and from the Canadian Prairie Nest Record Scheme (PNRS).

	MB (n = 74 nests)	PNRS (n = 34 nests)
Incubation daily survival rate	0.958	0.953
Nestling daily survival rate	0.948	0.939
Mayfield nest success	0.37	0.32
% Successful	54	44
% Depredated	39	47
% Deserted	3	9
% Failed	4	0
Young fledged/nest ($\bar{x}$ ± SE)	1.4 ± 0.2	1.7 ± 0.3
Young fledged/successful nest ($\bar{x}$ ± SE)	2.8 ± 0.2	3.8 ± 0.3
% Eggs laid that fledged young (n)[a]	35 (285)	20 (87)
% Eggs incubated to full term that fledged young (n)[a]	43 (232)	48 (21)

[a] Number of eggs.

brooding is also suggested by the apparent second peak in clutch initiation (Fig. 1). Cartwright and coworkers (1937) suspected that 3 of 5 observed pairs successfully raised two broods and stated that the second nests were initiated no later than one day after the fledging of young from the first. There was, however, no indication that the authors had marked birds to substantiate their claim.

Nest success.—Of 74 nests in which the nest fate was known, 54% fledged at least one young (Table 3), comparable to other ground-nesting passerines in the area (Davis 1994). Predation was the primary cause of nest loss in this study and for those nests recorded in the PNRS (Table 3). Nests initiated earlier in the breeding season were as likely to be depredated as nests initiated later in the season as the proportion of nests depredated before the median clutch initiation date (44%) was similar to those initiated after this date (31%; $\chi^2 = 1.192$, df = 1, $P > 0.05$). Nest desertion and failure not related to predation were not important factors influencing nest success. In our study, cattle trampled one nest, whereas inclement weather was believed to be responsible for the death of young in another nest, and a third nest with young failed for an unknown reason. Mayfield nest success on our study was 37% (Table 3). Daily survival rates were similar for the nestling and incubation stages in this study and for 34 nests from the PNRS in which Mayfield nest success could be calculated. Overall, a mean of 1.4 ± 0.2 young fledged per nest while successful nests fledged an average of 2.8 ± 0.2 young per nest (Table 3). Baird's Sparrow young fledged from 35% of the total number of eggs laid, and from 43% of the eggs incubated to full term in this study. Data from the PNRS indicate that 20% of the eggs laid and 48% of the eggs incubated to full term fledged young (Table 3).

Nests were situated an average of 72.5 ± 7.6 m (range = 6–365 m) from the nearest perch that was at least 1 m in height. Proximity to perches did not influence nest predation as the mean perch distance to depredated nests (70.1 ± 10.6 m) was not significantly different from those nests that were not depredated (70.8 ± 10.8 m; Student's t-test: $t = 0.095$, $P > 0.05$). Nest concealment also did not influence predation as no significant differences in concealment values were found for depredated (13.1 ± 1.5) and successful nests (9.6 ± 1.5; Student's t-test: $t = 1.587$, $P > 0.05$). The lack of relationship between nest concealment or perch distance with predation frequency suggest that birds were not the primary nest predators because avian nest predators often hunt from perches (Preston 1957) and rely on visual cues when foraging. Avian predators should, therefore, be influenced more by nest concealment than mammalian or reptilian predators (Clark and Nudds 1990). In fact, striped skunk (*Mephitis mephitis*) and thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*) likely depredated two nests as fresh skunk scat was located next to one depredated nest and another depredated nest was built over a thirteen-lined ground squirrel burrow. Other potential predators frequently observed on the study sites were: American Crow (*Corvus brachyrhyncos*), Northern Harrier (*Circus cyaneus*), western plains garter snake (*Thamnophis radix haydeni*), and Richardson's ground squirrel (*Spermophilus richardsonis*).

Cowbird parasitism.—Brown-headed Cowbirds parasitized 36% of Baird's Sparrow nests on our study area and laid 2.0 ± 0.2 eggs in parasitized nests (Table 4). More than

TABLE 4. Parasitism frequency and cowbird productivity in Baird's Sparrow nests from southwestern Manitoba (MB) and the Canadian Prairie Nest Record Scheme (PNRS).

	MB	PNRS
% Nests parasitized (*n*)	36 (74)	11 (27)
% Multiple parasitism (*n*)	67 (27)	100 (3)
% Cowbirds fledged from eggs laid (*n*)	21 (56)	29 (7)
Cowbird eggs laid/parasitized nest ($\bar{x} \pm$ SE)	2.0 ± 0.2	2.3 ± 0.3
Cowbird young fledged/parasitized nest ($\bar{x} \pm$ SE)	0.5 ± 0.1	0.7 ± 0.7

TABLE 5. Distribution of cowbird eggs laid in Baird's Sparrow nests in southwestern Manitoba (MB) and the Canadian Prairie Nest Record Scheme (PNRS).

No. of cowbird eggs laid	% Nests in MB (*n*)	% Nests in PNRS (*n*)
1	33 (9)	—
2	41 (11)	66 (2)
3	22 (6)	33 (1)
4	4 (1)	—

one cowbird egg was laid in 67% of parasitized nests (Table 4) and most of these nests contained 2 cowbird eggs (Table 5). Of the 61 nest records in the PNRS, 27 records with sufficient information revealed that 3 nests were parasitized (Table 4) and each nest contained more than one cowbird egg (Table 5). These records are likely not a reliable indication of the frequency of parasitism in prairie Canada since 50% of the clutches in the PNRS were initiated after 10 July, which is near the end of the cowbird laying season (Davis 1994).

Insight into the extent to which Baird's Sparrows were parasitized by cowbirds in the past is also difficult to determine because so few nests have been recorded. Friedmann (1963) indicated that there were four known instances of parasitism from North Dakota, one from Manitoba, and another from an unknown locality. The latter nest was most likely from the Rush Lake area of Saskatchewan (Raine 1894). The only other record of a parasitized Baird's Sparrow nest also came from Saskatchewan (Friedmann and Kiff 1985). It is interesting to note that, as in the current study, most of the parasitized nests recorded above contained more than one cowbird egg.

Although we cannot determine whether the results of this study are typical of the frequency of cowbird parasitism on Baird's Sparrow nests throughout the range, Davis (unpubl. data) found that 32% of 61 Baird's Sparrow nests located in southern Saskatchewan were parasitized by cowbirds and that 79% of these nests contained more than one cowbird egg. Because Baird's Sparrows nest entirely within the cowbirds' laying season (Davis 1994), and accept cowbird eggs, the species is highly susceptible to cowbird parasitism and may be a more common host than previous records indicate.

This study represents the first published account of Baird's Sparrows fledging cowbirds (Friedmann 1963, Friedmann and Kiff 1985). In the PNRS, one of the three parasitized nests may also have fledged cowbird nestlings because the nest was found with two cowbird and one host young that were "ready to fledge". Baird's Sparrows appear to be good quality hosts in southwestern Manitoba as they fledged 21% of the cowbird eggs laid in their nests (Table 4). This is higher than the cowbird nest success reported by Elliott (1978) for Grasshopper Sparrows (*Ammodramus savannarum*), Dickcissels (*Spiza americana*), and Eastern Meadowlarks (*Sturnella magna*) in Kansas, but similar for Grasshopper (22%) and Savannah (*Passerculus sandwichensis*; 30%) sparrows in southwestern Manitoba (Davis and Sealy, in press).

Baird's Sparrows fledged significantly fewer young from successful parasitized nests (1.9 ± 0.4) than from successful non-parasitized nests (3.0 ± 0.3; Table 6). On average, cowbird parasitism cost Baird's Sparrows 1.1 fledglings per successful nest, similar to the cost of cowbird parasitism found in studies of other ground-nesting host species (Nice 1937, Hill 1976, Elliott 1978, Zimmerman 1983, Trail and Baptista 1993; but see Smith 1981). Of eight species examined in southwestern Manitoba, only parasitized Savannah Sparrows incurred a larger cost (2.2 young) than Baird's Sparrows (Davis and Sealy, in press). Cowbirds often lower host productivity through the removal or damage of host eggs when they parasitize nests (Sealy 1992) and when cowbird nestlings out-compete host nestlings for food and space (Rothstein 1975,

TABLE 6. Hatching success and productivity ($\bar{x} \pm$ SE) in parasitized and non-parasitized Baird's Sparrow nests in southwestern Manitoba.

	Non-parasitized (n)[a]	Parasitized (n)[a]	P[b]
Clutch size	4.5 ± 0.1 (49)	3.1 ± 0.4 (22)	<0.001
Host eggs laid that hatched	3.2 ± 0.2 (49)	2.1 ± 0.4 (22)	0.03
Host eggs incubated full term that hatched	4.1 ± 0.1 (38)	3.3 ± 0.3 (15)	0.013
Host young fledged/nest	1.4 ± 0.2 (50)	1.4 ± 0.3 (22)	>0.05
Host young fledged/successful nest	3.0 ± 0.3 (23)	1.9 ± 0.4 (16)	0.023

[a] Number of nests.
[b] Wilcoxon rank sum.

Payne 1977). Egg removal by cowbirds may have been responsible for the lower productivity in parasitized nests because parasitized nests had significantly fewer eggs per clutch than non-parasitized nests (3.1 and 4.5 egg, respectively), and fewer young hatched from eggs which were fully incubated in parasitized nests compared to non-parasitized nests (3.3 and 4.1 young, respectively; Table 6). Thus cowbirds likely removed an average of one host egg per parasitized nest, fewer than reported by Elliott (1978).

Loss and degradation of grassland habitat are believed to be important factors contributing to the consistent and widespread decline of grassland birds in North America (Peterjohn and Sauer 1993, Herkert 1994, Knopf 1994). Habitat fragmentation, for example, reduces average patch size and increases the ratio of edge to interior habitat. This may ultimately lead to reduced productivity of grassland birds because of the increased activity of nest predators and Brown-headed Cowbirds along edge habitats (Gates and Gysel 1978, Johnson and Temple 1990). Our results appear to support this contention as nest predation and cowbird parasitism reduced Baird's Sparrow productivity in this highly fragmented region of the province. However, we cannot determine the overall impact of these factors on the seasonal productivity of Baird's Sparrows in this portion of their range without information on the number of breeding attempts per season and the reduction in productivity per breeding attempt (May and Robinson 1985, Smith and Arcese 1994). Clearly, more research on the impacts of nest predation and cowbird parasitism is required to determine the demographic effects of these factors on Baird's Sparrow populations in altered and native landscapes across the sparrow's breeding range.

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